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A MORPHOLOGICAL COMPARISON OF CENTRAL AUSTRALIAN SEEDGRINDING IMPLEMENTS AND AUSTRALIAN PLEISTOCENE-AGE GRINDSTONES

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ABSTRACT

The morphology of grindstones used for seedgrinding in Central Australia is described. A comparison with grindstones of late Pleistocene age shows that these have few of the diagnostic features of seedgrinding implements. It is concluded that there is no positive evidence for the processing of seed foods as early as 15,000-18,000 yrs BP in Australia.

Keywords: arid zone, Central Australia, ethnography, grindstones, pleistocene implements, seed grinding.

INTRODUCTION

Seed foods were among the most dependable and predictable of the plant foods available to Aboriginal groups in arid Australia. Acacia seeds were gathered and roasted, then cracked and ground into flour. Similarly grass seeds, such as *Panicum decompositum* (native millet) and *Eragrostis eriopoda* (naked woollybutt), were gathered, winnowed and husked, and wet-ground into paste. Most ethnographic accounts mention the importance of seeds (Spencer and Gillen 1899:7, 22; Spencer and Gillian 1912:264; Chewings 1936:10, 26; Meggitt 1957; Tindale 1972:250, 1977; Allen 1972) and recent ethnobotanical research has confirmed this (Golson 1971; Latz 1982). For instance, of the 140 plant food species available in Central Australia, 75 were exploited for their seed (Latz 1982: Table IV). Seed foods were especially important to groups living in arid Australia, because other bush foods were quickly depleted. These resources therefore provided the economic base for many features of Aboriginal society as it was observed in the 19th century.

Presently the best prospects for tracing the use of seed foods rests with the recognition in archaeological deposits of the grindstones used to process them.
Grindstones first appear in archaeological assemblages in western New South Wales ca. 15,000 yrs BP and in Arnhem Land, southwest Western Australia and the eastern Kimberley region ca. 18,000 yrs BP (Fig.1) and this is widely interpreted as reflecting a broad economic change towards intensive use of seeds at this time (White and O'Connell 1982:70-71; O'Connell and Hawkes 1981:115; Bowdler 1977:225-36; Tindale 1977:347-8; Mulvaney 1975:87, 133; Allen 1972). However none of the early grindstones have been described in any detail.

In this paper the morphology of grindstones used for seedgrinding in Central Australia is described. I suggest that a variety of different implements are subsumed under the term 'grindstone' and that seedgrinding implements can be distinguished from other types of grindstone by their morphology. The Pleistocene-age grindstones are examined and their interpretation as seedgrinding implements is reviewed below.

ETHNOGRAPHIC REFERENCES TO GRINDSTONES

Descriptions of grindstones given in the ethnographic literature are too brief to link specific traits with particular tasks. However the wide range of uses reported should caution against the uncritical assumption that any grindstone is necessarily a seedgrinding implement and suggests that archaeological specimens will need to be evaluated on their individual merits.

Grindstones generally served to process various foodstuffs which were otherwise

Fig. 1. The Australian arid zone in relation to sites with Pleistocene-age grindstones: 1, Western NSW sites 2, Western Arnhem Land sites; 3, Quininup Brook; 4, Miriwun; 5, Kenniff Cave.

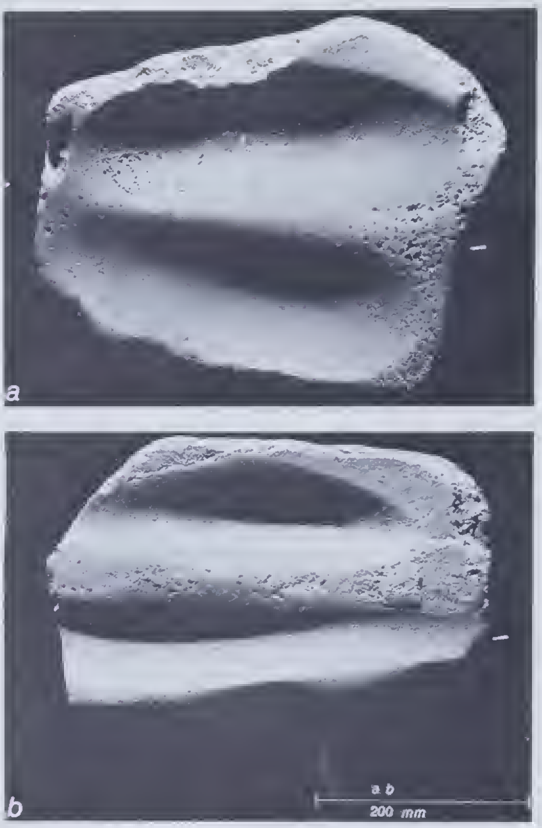

Fig. 2. *Millstones*: a, arrow indicates rejuvenation stippling; b, arrow indicates worn lip.

inedible, or at least unpalatable, such as cartilage, seeds with tough husks or coats, fibrous roots and vegetables.

In arid Australia, they were used to pulverise lizards (Hayden 1979:141), bone, cartilage or small animals (Gould *et al.* 1971:163-4, Fig. 12), prepare paste from dried solanum fruit (Gould *et al.* 1971:163-4; Peterson 1977, Pl. 10.1), grind various seeds (Horne and Aiston 1924:53-6; Tindale 1977:346-7; Gould *et al.* 1971:163-4, Fig. 13) and to crack and grind nuts (Thomson 1964:402).

In northern Australia, Peterson (1968) records the use of grindstones to crack nuts, pulp fruit, soften cooked roots, break open bones for marrow, pulp pieces of cooked lizard, fish or kangaroo and to grind cycad nuts or waterlily seeds into flour (see also Spencer 1928:774). In southwest coastal Queensland, grindstones were used for grinding or pounding fernroot (Kamminga 1981:35; Gillieson and Hall 1982).

Grindstones were also used for a variety of tasks not directly concerned with food processing. In some cases these functions were clearly not the primary function of the implement concerned. In arid Australia, grindstones are reported to have been used to sharpen or smooth wooden artifacts (Hayden 1979:114; Horne and Aiston 1924:56; Thomson 1964:408-9, Pl. 36), sharpen stone axes (Horne and Aiston 1924:56; Spencer 1982: P. 1404), grind up ochre (Spencer 1982: Pl. 771), prepare bush tobacco (Brokensha 1978:29-31) and prepare resin (Brokensha 1978:64-6). In northern Australia, Peterson (1968) reports the grinding of pigments and of resin for hafting.

CENTRAL AUSTRALIAN GRINDSTONES

Five types of grindstone have been recognised on sites in Central Australia. These are defined on the basis of overall form and type of functional surface. Each type is described below:

Millstones
(Figs 2, 3).

These are flat surfaced slabs with one or more long shallow grooves worn into the grinding face (O'Connell 1977:274, Fig 7d). They functioned as nether grindstones used for the wet milling of a variety of seeds, usually soft seeds or those which have been subject to an initial dry grinding process in a mortar (Tindale 1977:346-7; Horne and Aiston 1924:53-6; pers. obs.).

The observations below are based upon the examination of 30 complete specimens from 15 sites, supplemented by field observations of other specimens left in-situ. The sample includes one millstone blank and three specimens which exhibit both millstone and mortar surfaces.

Overall morphology. Millstones are variable in overall dimensions and weight. In the sample they range from 400 x 300mm to 600 x 400m in length and breadth, from 25 to 150mm in thickness and from 4 to 30 kg in

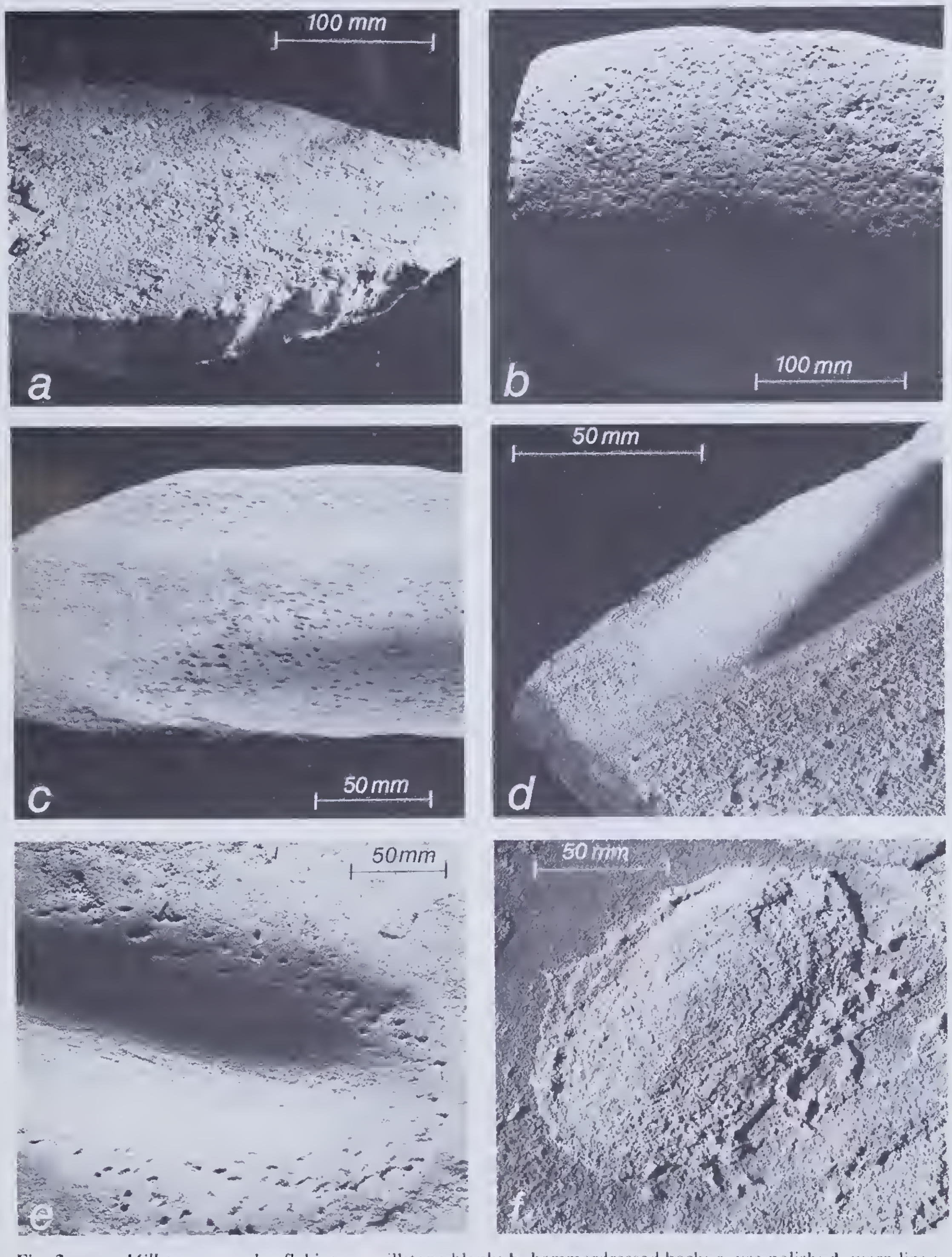

Fig. 3. a - e, *Millstones:* **a**, edge flaking on millstone blank; **b**, hammerdressed back; **c**, use polish; **d**, worn lip; **e**, rejuvenation stippling; **f**, *Mortar* showing preparation of working surface by pecking.

weight. Overall size is strongly determined by the form of the raw material, in particular whether this was a quarried slab or a sandstone boulder. A large surface area is necessary for the long grinding action with which these implements are used and specimens smaller than 300 x 400 mm are possibly too small to use efficiently. Specimens from sites on the sandplains, more distant from the supply of stone, tend to be relatively light, thin, more extensively trimmed and heavily worn.

Manufacture. Eleven millstones in the sample show some form of edge trimming. Commonly this is flaking or chipping of the edge (Fig. 3a) or less frequently, hammer-dressing. In one specimen the peripheral flaking also extends across the dorsal surface reducing the thickness of the implement.

In some specimens the back, or sometimes the face, of the millstone is hammer dressed (Fig. 3b). This is a coarse, closely spaced pecking which roughly dresses the implement to shape. In the sample four millstones are hammerdressed in this fashion.

Use wear. Millstones in the sample have up to four separate ground surfaces. These are long, (200-450 mm) and narrow (60-140 mm) in outline and concave in section. Some are barely worn while others are worn to a groove up to 25 mm deep. These surfaces are finely abraded and very smooth. They are sometimes positioned in the centre of one face or alternatively on one edge so that one side of the groove is open. Where more than one working surface is present on a face these are usually parallel rather than convergent or intersecting. The initiation of a new working surface and its position on the millstone is probably linked to the availability of mullers or handstones of a suitable size and curvature (see below).

A reflective polish (Fig. 3c) is present on 15 of the millstones in the sample. It is often but not always restricted to the working surface and it is also present on the other types of seedgrinding artifacts described below. The conditions leading to its formation have not been determined but it is possible that it is a form of phytolith polish ie. sickle gloss (see Kamminga 1979). Alternatively it may be a fine abrasive polish, as Kamminga (1977:209) has suggested for the intense use-polish on eloueras from western Arnhem Land.

Repeated use of a millstone often produces a surface which is too smooth to shear the seeds during grinding. Such a surface may be rejuvenated by light pecking to roughen it. This results in a scatter of small, deep, discrete puncture marks (Figs 2a, 3e) which I have called 'rejuvenation stippling'. Fifteen specimens in the sample have rejuvenation stippling. In several specimens a stippled surface has been cut through by a new working surface leaving a ring of stipple marks. Harder varieties of sandstone appear to develop a shiney surface relatively quickly and presumably need to be rejuvenated more often than softer friable varieties.

Longitudinal scoring or striations are often present on the working surfaces and indicate the direction in which the topstone has been used. In the sample eight specimens have striations visible on hand examination.

The practice of pushing the ground meal over the edge of the millstone (see Tindale 1977:346) results in a worn lip (Figs 2b, 3d) at one end of the working surface. In the sample 20 of the implements, and 28 of the 65 separate working surfaces, exhibit a definite lip. In some cases the lip is comprised of a rounded edge and a smoothly abraded area connecting it with one end of a working surface. In other examples the lip is a deeply worn, concave ground area somewhat narrower than the working surface. Working surfaces associated with worn lips are marginally deeper than those without.

Mullers
(Fig. 4a-c)

These are thin hand held seedgrinding artifacts used together with millstones in the wet milling of soft seeds (Tindale 1977:346-7; O'Connell 1977:274, Fig. 7a-b).

They vary from oval, sub-rectangular or triangular in outline and from plano-convex to bi-convex in section. They are about 80 x 100 mm in length and breadth, from 10 to 30 mm thick and 100 to 250 g in weight. Dimensions and mass vary with degree of wear.

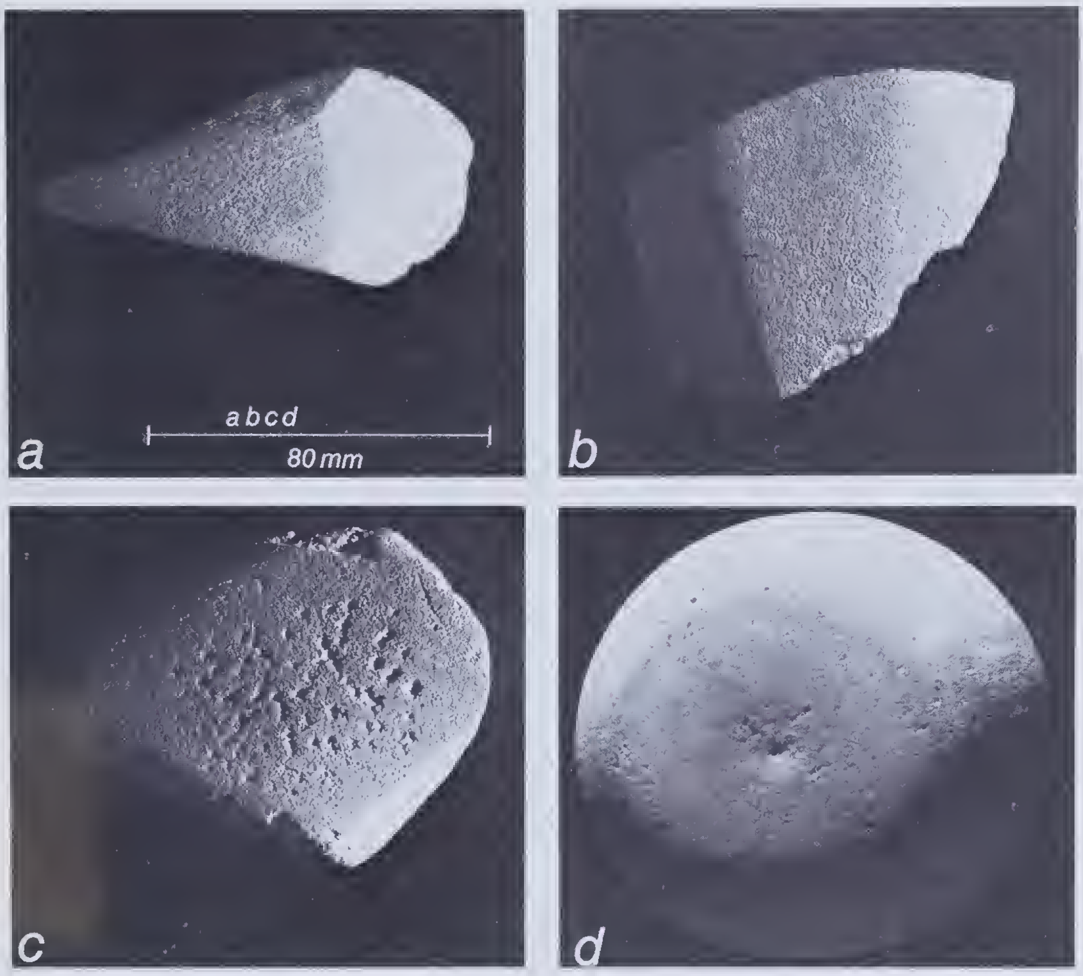

Fig. 4. a - d, *Mullers*: **a**, showing facets intersecting to form edge, **b**, outline arrow indicates use polish **c**, rejuvenation stippling; **d** *pestle* showing ground surface with small pecked depression.

A ground facet is produced by abrasion on the heel of the muller, as the implement is tilted upwards during use, with the pressure on the rear edge. Characteristically this facet is oblique to the main axis of the implement. Heavily worn specimens have several different facets and the edges of the implement are frequently formed by the intersection of these working surfaces (Fig. 4a). Most mullers have a marked median keel where facets intersect on the face of the implement.

Many mullers also exhibit use polish similar to that on millstones (Fig. 4b). Some specimens have rejuvenation stippling (Fig. 4c).

Mortars
(Fig. 5)

Central Australian mortars are flat surfaced blocks with a shallow oval or circular basin ground in one or both faces. They functioned as mortars for the preliminary pounding and crushing of hard acacia seed such as *Acacia victoriae* (prickly wattle) and *A. coriacea* (dogwood). These implements have not previously been described although Peterson (1968), Horne and Aiston (1924:53-6) and Roth (1904:23) refer to functionally analagous implements.

The observations below are based upon the examination of 19 complete specimens from 5 sites, supplemented by field observations of other specimens left in-situ. All of these sites are located in the central ranges. The sample includes the three specimens which exhibit both mortar and millstone surfaces.

Overall morphology. Few of the mortars in the sample are extensively modified.

Overall size is largely a feature of the size of sandstone blocks locally available. Mortars in the sample vary from 180 x 170mm to 520 x 400mm in length and breadth, from 70 to 210 mm in thickness and from 4 to 35 kg in weight.

Manufacture. Four mortars in the sample have been flaked around the margins (Fig. 5a). One of these is a specimen with both millstone and mortar surfaces.

Several specimens have been hammer dressed to initiate or prepare the working surface and the remnant of this can be seen around the periphery of the depression. This is well illustrated on one specimen where the working surface has been formed in this fashion but not subsequently used (Fig. 3f).

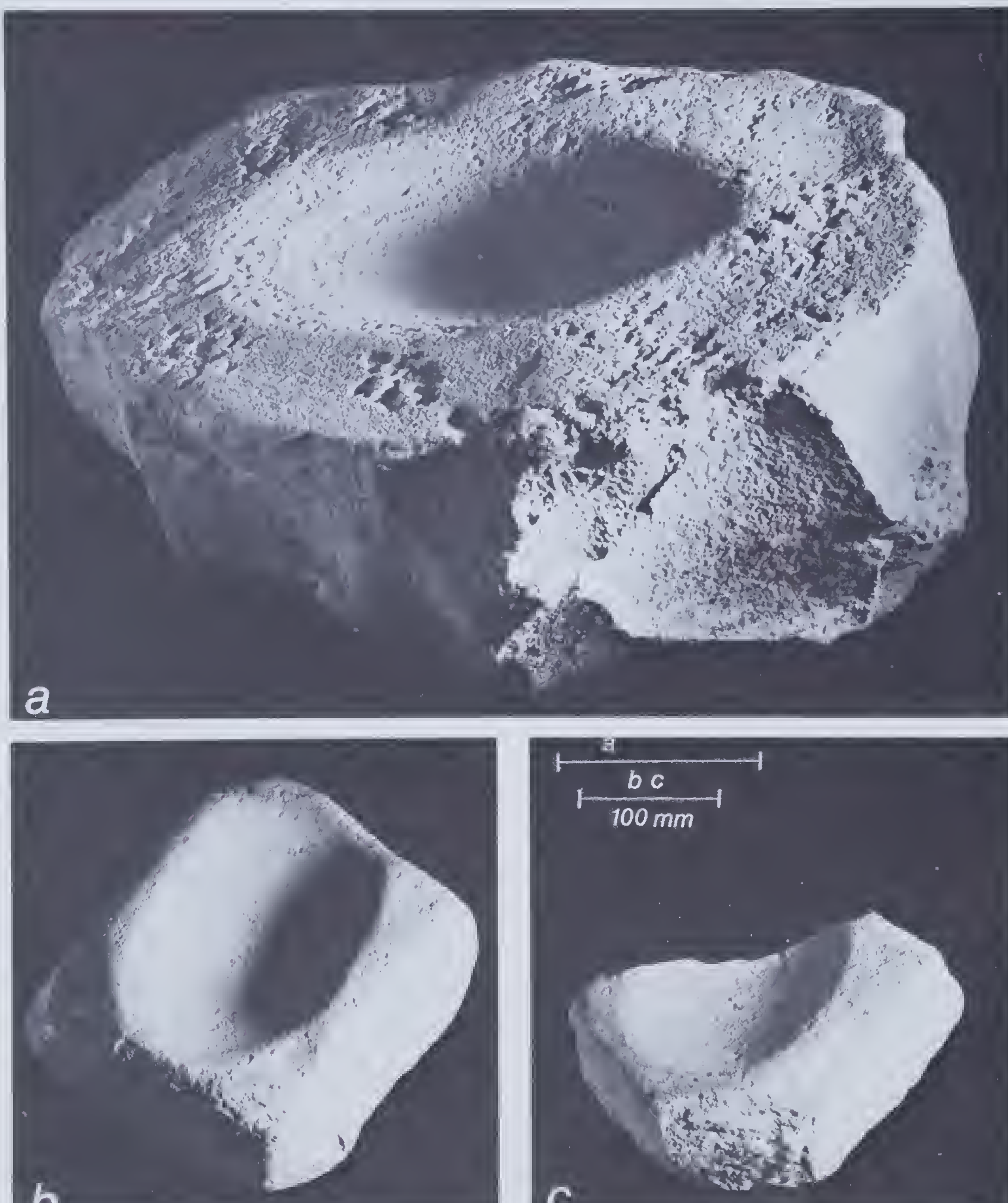

Fig. 5. a - c, *Mortars:* a, showing large mortar with flaked edge.

Use wear. The working surface on mortars is oval or circular in outline, 100 to 300 mm in diameter, up to 27 mm deep and concave in section. These implements have up to two separate circular working surfaces; one on each face. In addition three specimens in the sample also have long narrow milling grooves adjacent to this working surface.

The working surface is not smoothly ground on all specimens.

Four of the mortars also exhibit use polish similar to that present on millstones. In three specimens this appears as small patches adjacent to the working surface. On the remaining specimen the polish is on the working surface.

Pestles
(Fig. 4d)

These are fist-sized water-worn cobbles about a kilogram in weight, used on a mortar to pound and crush hard seeds (O'Connell 1977:274, Fig. 7c).

They are roughly circular in outline and domed or rounded in section. The latter attribute is required for their use in a rolling or rocking action when crushing seeds.

The ground surfaces on either side are flat or slightly convex and often have a distinctive small pecked depression in the centre. Edges are battered, suggesting secondary use as a hammerstone.

Some implements have use polish on the working surfaces.

Pestles are highly curated and are consequently rare on sites (cf. Horne and Aiston 1924:53-6).

Amorphous grindstones

These are otherwise unmodified slabs, rocks or pieces of stone, with flat poorly defined ground or abraded patches on one face. The ground surfaces may be smooth but lack use polish and do not form well defined discrete surfaces. Pitting or striations are sometimes present. These are expediently used implements rather than a formal type.

Of the various seedgrinding implements, millstones and mullers are the most distinctive. Millstones are relatively specialised implements which are carefully trimmed before use and rejuvenated when worn. Mullers wear rapidly and are quite diagnostic of wet-milling. Mortars and pestles however are less useful as indicators of seed processing. If found in assemblages which also contain millstones or mullers they would certainly indicate the processing of hard seeds. If found in other contexts, particularly outside the arid zone, their function may be ambiguous.

ETHNOGRAPHIC TAXONOMY

Mullers and pestles are called *purle* and *atarte* by Aranda and Alyawara speaking people in Alice Springs. Large grindstones, irrespective of type, are called *athere*. Anmatyere speaking people living at Utopia station identified the same types as *tyenge*, *alyere* and *athere* respectively.

The functions of the different types of grindstones are clearly distinguished by Aboriginal people even though no linguistic distinction appears to be made in the case of large grindstones. Millstones and mullers are explicitly said to be used for wet milling grass seeds, and soft acacia seeds such as *Acacia aneura* (mulga) seeds. Mortars and pestles are said to be used for pounding and dry grinding hard seeds such as *A. coriacea*, *A. victoriae* and *Brachychiton gregorii* (kurrajong). One informant was able to accurately describe the different types of large grindstone when shown the associated topstones.

Amorphous grindstones are distinguished from seedgrinding implements. A large amorphous grindstone recovered in an excavation was interpreted by one of the Aboriginal custodians of the site as used for 'sharpening wood and grinding up things', and use as a seedgrinder was specifically excluded. Similarly, small amorphous grindstones in rockshelters in the Finke gorge, were identified by my Western Aranda companions as used for grinding up bush tobacco. This identification appeared to be largely circumstantial but there was no confusion of function with millstones found at other sites.

SEEDGRINDING AT UTOPIA

The collection and preparation of seed food is rarely done today as it is fairly laborious and flour or bread is readily available as a substitute. However an opportunity arose in June 1983 to witness a demonstration of seedgrinding by An-

Fig. 6. a, Anmatyerre women pound and crush *Acacia victoriae* seeds; **b**, *Acacia aneura* seeds are wet milled.

matyerre women living on Utopia station. These observations supplement Aboriginal statements about the use of the various types of grindstones.

The seeds processed on this occasion were *Brachychiton gregorii, Acacia aneura, A. coriacea* and *A. victoriae.* Two different groups of women were involved on three successive days. A small number of grindstones and unmodified rocks of different mass and morphology were supplied before the seedgrinding to supplement the implements locally available. The actual choice of implement was not otherwise influenced.

All the seeds required preparation before grinding. The acacia and kurrajong seeds were parched or roasted in hot soil to make them brittle before grinding. With the exception of *A. aneura* these seeds were then pounded and crushed prior to wet milling. Women initially selected a mortar and a pestle for pounding these hard seeds. On successive days a mortar was initially selected, used for a short period, rejected, tried again and then rejected in favour of a flat surfaced slab (Fig. 6a). This suggests that while a mortar was thought to be the appropriate implement for this task, there were problems with the specimen available. One explanation given by the women was that the mortar was too deep, *kwenele.* It appeared that the curvature of the mortar was too marked to accomodate either of the pestles available. On another occasion the mortar was rejected because the area of the face was too small to allow the women to stockpile seeds or meal close to the working surface. On one occasion when using a flat slab as a de-facto mortar a woman carefully placed a piece of cloth as a ring around the working surface to prevent the seeds from going astray thereby simulating use of the formal artifact.

The pestle was used in a short pounding action to initially break up the seeds and then with a rocking, crushing action, similar to kneading, to reduce them to a coarse meal. No one knew the origin of the small pecked depression in the face of the pestles.

The course meal produced was subsequently wet milled to produce a paste. *B. gregorii* was eaten after processing in a mortar without further treatment apart from the addition of a little water as a binding agent. For the wet milling (Fig. 6b) both groups of women chose the same large millstone, one with a prominent groove and rejuvenation stippling on one face. A flat unmodified handsize rock was selected for use as a muller. The well worn mullers in the collection were ignored. When this choice was later queried the explanation given was *akilye ampwele* ie. the small ones are old. In other words the available mullers were considered to be too small or too worn down to be useful and a suitable flat rock was pressed into service. This impromptu muller was used with a long grinding action with it tilted slightly up at the front. During the demonstration it acquired a worn facet on the rear edge. On the millstone the groove or working surface was only used for stockpiling seed and a fresh section on one edge of the face was used for the wet milling. The explanation given for this was that the groove was too deep, 'too much *iperte*'. This suggests that the choice of a flat impromptu muller, which did not fit the existing groove, made it necessary to use a fresh area on the face of the millstone.

The rejuvenation stippling was shown to be made with the sharp edge of a worn muller when the surface of the millstone became shiney or slippery, *alyelkelirrike.*

These observations confirm the association of the various grindstone types with specific processes and varieties of seeds and also give some idea of the interrelationship between the availability of suitable mullers and pestles and the use of the large grindstones.

THE PLEISTOCENE-AGE GRINDSTONES

The principal grindstones cited as evidence for seedgrinding during the Pleistocene come from sites in two regions; (a) the Willandra lakes and Darling basin and (b) western Arnhem Land. Other Pleistocene age grindstones have been reported from the sites of Miriwun, and Kenniff Cave. These are described below from firsthand examinations of the specimens. Published information about the Quininup Brook specimens, is also reviewed below.

I have chosen to adopt a conservative approach to the recognition of seedgrinding implements. As the grindstones recovered from archaeological sites are usually frag-

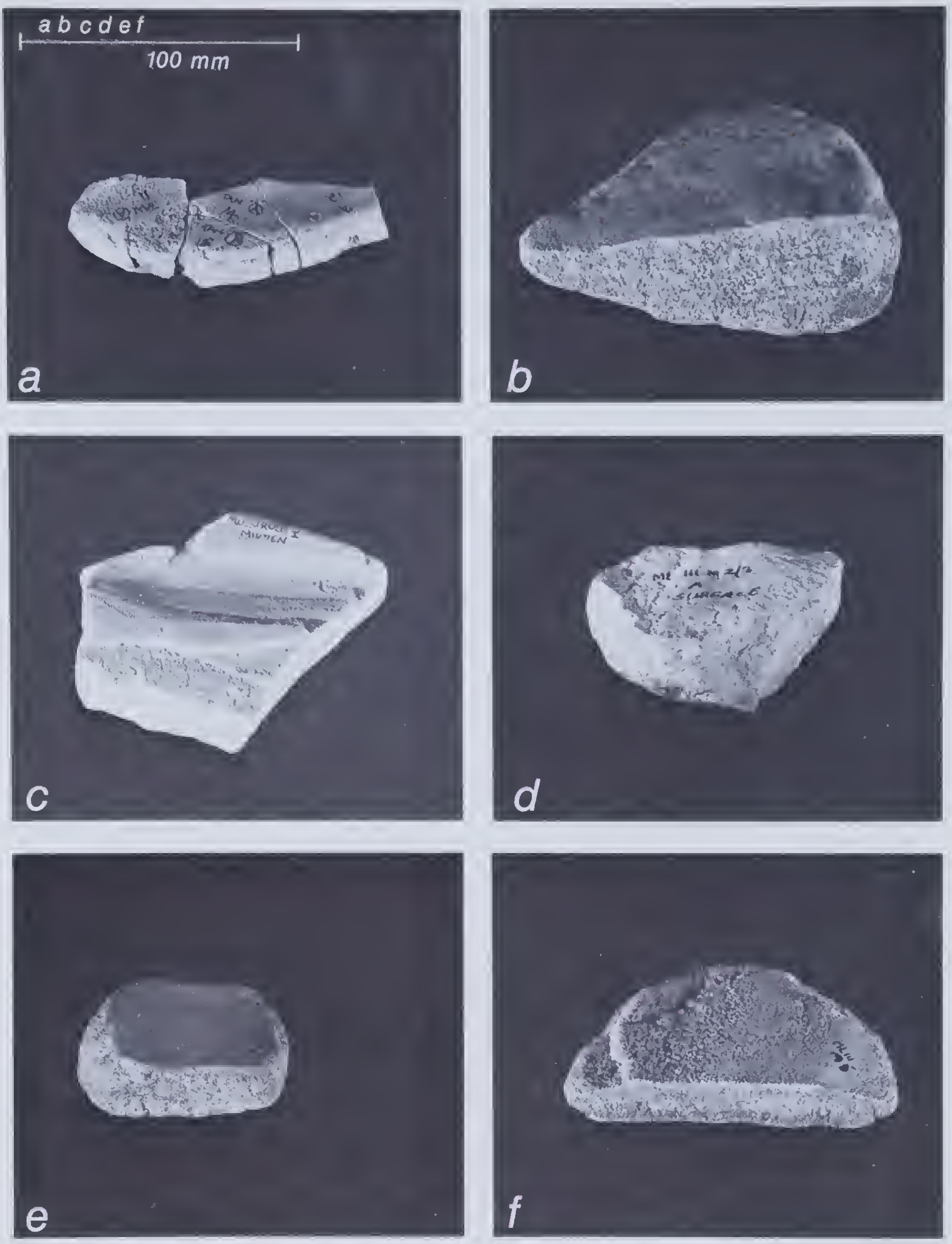

Fig. 7. Willandra lakes and Darling basin grindstones: **a**, specimen 1 *Lake Tandou lunette I;* **b**, *Mulurulu I;* **c**, *Mulurulu I;* **d**, *Mulurulu IIIA midden 2/3;* **e**, *Mulurulu IIIA midden 5;* **f**, *Mulurulu IIIA midden 5.*

ments of whole implements many specimens, irrespective of the type of grindstone, will lack diagnostic features. In this analysis only specimens which retain sufficient characteristics to be positively identifiable as seedgrinding implements are accepted.

The Willandra lakes and Darling basin

Allen (1972) recovered grindstones from

six sites dated between 12,500 yrs BP and 15,700 yrs BP: *Lake Tandou Lunette I and III*, *Mulurulu I and IIIA* and *Leaghur Backshore I and III.* With the exception of the grindstones from Lake Tandou lunette I all of the specimens are surface finds.

I have examined the grindstones from Lake Tandou lunette I and III and Mulurulu I and IIIA middens 1-5 but could not locate the material from Leaghur Backshore I and III or the single grindstone from Mulurulu IIIA middens 6-12. The two grindstones reported from Lake Tandou lunette III are two small pieces of sandstone without evidence of any grinding and do not merit further comment here. A surface collection from another site, Tandou Creek I, was considered by Allen (1972:240-44) to be a mixture of occupations of different age and he attributed the carbonate encrusted specimens to a Pleistocene occupation. As the age and context of these artifacts is questionable I have excluded them from my analysis. The remaining specimens are illustrated in Fig. 7a-f and are described individually below.

1. **Lake Tandou lunette I**. Described as 'in situ' by Allen. Part of a single small grindstone broken into 6 fragments; 4 fragments can be rejoined along fresh breaks (a) and the other 2 fragments (b and (c) have weathered margins.
   (a) Length (L) 106 mm, Breadth (B) 40 mm, Thickness (T) 11 mm, Weight (W) 65.9g (Fig. 7a). Small flat unmodified slab of fine grained sandstone. Subangular in outline and rectangular or lamellate in section. Small area of abrasive smoothing (approx. 65 x 22 mm) on one face, most pronounced on fragment no. 12 (Fig. 7a right hand side). There are no distinct margins to the abraded area, no rejuvenation stippling, striations, use polish, or edge trimming.
   (b) L 64 mm, B 43 mm, T 17 mm, W 55.3g. Flat piece of fine grained sandstone with weathered breaks forming 3 margins. Not ground but presumed to be part of the same implement because of its provenance.
   (c) L 30 mm, B. 15 mm, T 10 mm, W. 5.3g. Small fragment of fine grained sandstone with weathered margins. Not ground. Presumed to be part of the same implement because of its provenance.
2. **Mulurulu I**. L 97 mm, B 129 mm, T 44 mm, W 568g (Fig. 7b). Unmodified slab of medium grained sandstone with an unpatinated break forming one margin. Subangular in outline and section. Small area of light abrasive smoothing (55 x 34 mm) on the face. No distinct margins to this abraded area, and no rejuvenation stippling, striations, use polish or edge trimming.
3. **Mulurulu I**. L 93 mm, B 86 mm, T 27 mm, W 362.8g (Fig. 7c). Small flat slab of fine grained sandstone. Subrectangular in outline and in cross-section with parrallel faces. Smoothly abraded areas on both faces and 2 sides. Three abraded areas are flat and the fourth is a narrow groove (83 mm long x 27 mm wide x 4 mm deep) ground into one face. There is no edge trimming, rejuvenation stippling, striations, or use polish.
4. **Mulurulu IIIA midden 2/3**. L 91 mm, B 74 mm, T 42 mm, W 403.5g (Fig. 7d). Unmodified chunk of silcrete. Subangular in outline and cross-section, with cortex on base. Small area of abrasive smoothing (42 x 36mm) on the face with the abrasion restricted to high points of the surface. The abraded surface is flat and without distinct margins, rejuvenation stippling, striations, or use polish. There is no edge trimming.
5. **Mulurulu IIIA midden 5**. L 76 mm, B 56 mm, T 31 mm, W 219.2g (Fig. 7e). Small block of sandstone. Rectangular in outline and wedge-shaped in cross- section. One face is flat with a fine, smoothly abraded surface. The specimen appears to be complete as 3 sides are patinated and the fourth is lightly abraded. The ground area on the face has distinct margins but no rejuvenation stippling, striations or use polish.
6. **Mulurulu IIIA midden 5**. L 80 mm, B119 mm, T 19 mm, W 296g (Fig. 7f). Flat slab of medium grained sandstone. Semicircular in outline with a break forming the straight margin. Thin and flat in cross-section. Flat abraded areas covering all of one face and part of the other. The edge appears to have been trimmed to

the present outline by flaking. Abraded areas have no distinct margins, rejuvenation stippling, striations, or use polish. On the margin of one face there is a slight facet, oblique to the main axis of the implement, with a smooth abraded surface (30 x 25 mm) (Fig. 7f right hand side). The break sections this facet.

Of these six specimens I would classify, 1, 2, 4 and 5 as amorphous grindstones. They lack evidence of deliberate shaping and in the case of specimens 1, 2 and 4 the abraded areas are only lightly worn and very restricted in extent. Specimen 5 has a heavily abraded face but is probably too small to have functioned as a muller. Specimen 3 is clearly not a seedgrinding implement and the peculiar abraded patches on its margins suggest use as a woodgrinding implement. The narrow ground groove on one face suggests use for sharpening wooden implements. Specimen 6 may be part of a

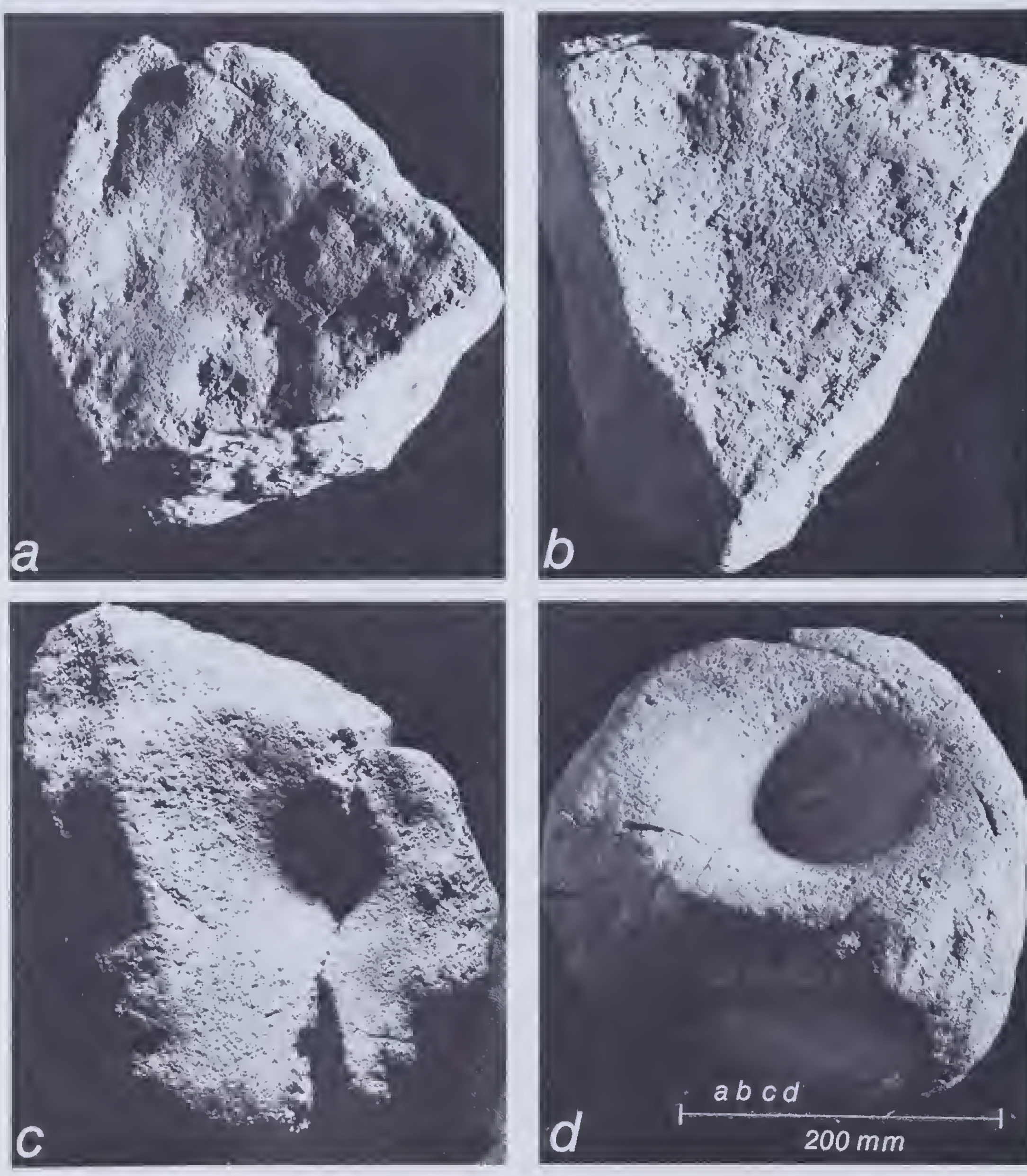

Fig. 8. Western Arnhem Land grindstones: **a - c**, Pleistocene specimens from *Malakunanya II*; **d**, ground hollow type grindstone. Surface find from Kapalga.

muller but it does not retain sufficient diagnostic features to allow positive identification. An oblique facet is a characteristic of mullers but unfortunately not sufficient of the facet is preserved on this specimen to be certain of its form.

Western Arnhem Land

Kamminga and Allen (1973) excavated three grindstones of Pleistocene age from *Malakunanya II* and Schrire (1982) excavated one from the Pleistocene levels of *Malangangerr* and from *Nawamoyn*.

The three specimens from Malakunanya II are associated with a date of 18,040±320 BP (SUA-265). These grindstones are illustrated in plates 7a-c and described more fully below.

1. **Malakunanya II.** L 250 mm, B 230 mm, T 100 mm, W 10 kg (Fig. 8a)
   Untrimmed block of local sandstone. Subangular in outline and rectangular in section. Thick sectioned with parallel faces. The working surface is a flat ground area approx. 130 x 130 mm. It is abraded but not smooth. There are no distinct margins to the working surface, no use polish, stippling or striations. Red and white staining is present on this surface and is possibly ochre.

2. **Malakunanya II.** L 320 mm, B 300 mm, T 140 mm, W 13 kg. (Fig. 8b)
   Untrimmed block of local sandstone with quartz inclusions. Triangular in outline and sub-angular in section. Thick block with slightly concave surface and irregular base. The working surface is an abraded area approximately 190 x 200mm with no distinct margins, polish, stippling or striations. The concave surface is a natural feature of the sandstone block rather than due to wear. The abrasion or grinding is restricted to the high points of the surface.

3. **Malakunanya II.** L 360 mm, B 250 mm, T 17 mm, Wt 15 kg. (Fig. 8c)
   Untrimmed block of local sandstone with quartz inclusions. Sub-angular in outline and section. The working surface is a small, discrete, shallow, ground hollow, diameter 78 mm, depth 19 mm. A modern break splits the specimen into two pieces incidently sectioning the ground hollow.

The grindstone from Malangangerr was excavated from levels dated to about 20,000 yrs BP (Schrire 1982:108, Pl. 13) but the excavator suggests that it may pre-date this. The specimen is described as a small round hollow, ground into a large fallen rock slab that lay at the base of the excavation.

The grindstone from Nawamoyn was excavated from levels dated to 21,000 yrs BP (Schrire 1982:144). It is described as a rock, 300 x 250 x 100 mm, with a small depression, 110 mm diameter, ground into its surface (Schrire 1982, Pl. 19).

Clearly none of the western Arnhem Land grindstones bear comparison with Central Australian seedgrinding implements. The working surfaces are of a quite different form to that of the millstones or Central Australian mortars. I would classify two of the Malakunanya II specimens, 1 and 2, as amorphous grindstones. They may have been used for a variety of tasks although the ochre staining on one suggests use as a palette. The remaining grindstone and the specimens from Malangangerr and Nawamoyn are clearly examples of a separate formal type, distinguished by small circular ground hollows. This type is widespread in sites on the coastal plains east of Darwin and in rockshelters along the Arnhem Land escarpment. Fig. 8d shows a specimen from Kapalga. The use of this type of grindstone has not been determined but it clearly would not be suitable for processing any but the smallest quantities of seed.

Miriwun

Grindstones are reported to be a component of the early phase assemblages at Miriwun rockshelter (Mulvaney 1975:133; Dortch 1977a:121, 1977b:30). These assemblages span a significant disconformity between the Pleistocene deposits, dated to 18,000 yrs BP, and the overlying late Holocene strata, dated to 3,000 yrs BP.In my examination of the Miriwun collection I have identified eight grindstones. Only one of these is from levels attributed to the early phase. This specimen is described below. It was excavated from the lower part of the light brown silty earth and the excavator considers that it probably dates to ca. 3,000 BP rather than 18,000 BP (Dortch, pers. comm.). In any case it is an amorphous grindstone rather than a seedgrinding implement as the description below illustrates.

Miriwun Trench 9b East. L 115.4 mm, B 84.1 mm, T 67.7 mm, W 901g. Quartzite pebble with lightly abraded patch (88 x 70 mm) on one face. The abraded area has no distinct boundary and the grinding is heaviest in the centre.

Kenniff Cave

The Kenniff Cave excavations (Mulvaney and Joyce 1965) produced a grindstone bracketed between the dates 13,000 and 16,000 years B.P. This is described below. It is best classified as a hammerstone with some secondary abrasion.

Kenniff Cave 1964 Spit 30. L 75.6 mm, B 64.5 mm, T 34.5 mm, W 184.5g. A Fragment of a small basalt pebble. One end is battered. Small abraded patch (25mm x 10mm) on one face. This abrasion appears comparatively fresh.

Quininup Brook

The grindstones from Quininup Brook, in southwest Western Australia, are from a surface collection on a deflated area. Subsequent excavations have established that the eroded artifacts derive from a cultural horizon dated between 10,000 and 18,000 yrs BP.

Seven grindstones are described by Ferguson (1981:624, Fig 6). These comprise four lower and three upper grindstones. The published descriptions do not suggest that any of these specimens are unequivocally seedgrinding artifacts. Ferguson (1981) lists a wide range of possible functions for these implements but has recently stated that none of the Quininup Brook grindstones closely resemble the seedgrinding implements described from Central Australia (Ferguson, pers. comm.).

The two large grindstones have pecked hollows and appear to be morphologically similar to the western Arnhem Land, ground hollow type grindstone.

DISCUSSION

On morphological criteria none of the Pleistocene-age grindstones can be positively identified as seedgrinding implements. The Pleistocene grindstones differ in their overall form and in the morphology of their functional surfaces from Central Australian seedgrinders. They tend not to be heavily abraded, nor shaped or prepared prior to use, nor are the working surfaces rejuvenated when worn. In most respects the Pleistocene grindstones appear to be expedient rather than formal implements.

However among the Pleistocene grindstones from western Arnhem Land there are several examples of a distinct formal type which I have referred to as the 'ground hollow' type. Other terms such as 'pounding hole', 'bedrock mortar' or 'cup mark' may be more appropriate. The function of these grindstones is unknown but even if they are ultimately shown to be used for processing seeds, which I think is unlikely, they clearly represent a separate technological development to the arid zone implements.

The processing of seeds in Australia as early as 15,000 - 18,000 years ago is not supported by this study of the artifacts. Nor is there any other evidence available which suggests that seed foods were a major resource at this time eg. direct recovery of seeds, analysis of organic residues, examination of possible phytolith polishes or phytoliths in the interstices of working surfaces. However, with the exception of the western New South Wales material none of the relevant specimens are from sites either within the present arid zone (see Fig. 1) or the likely boundaries of an expanded late Pleistocene arid zone. In contrast, the ethnographic data for intensive seed use has come from arid and semi-arid egions and it is clear that the history of these resources will only be documented by archaeological work in these areas.

There is no doubt that grindstones were used by Aboriginal groups in a variety of different environments in the late Pleistocene. Arid zone seedgrinding implements can be seen as an elaboration of this basic technology. However the assumption that all grindstones are intrinsically seedgrinding implements is incorrect and has tended to obscure the need for the detailed description and illustration of key artifacts.

For the present, the antiquity and history of the use of seedfoods, and the economies underwritten by these resources, should be considered an open question. Larger assemblages from Pleistocene age sites could substantially increase the probability of recovering identifiable specimens and an analysis of the formation of use polish on seedgrinding implements may ultimately increase the range of specimens which can be confidently identified as such.

A review of the present archaeological evidence for the development of seedgrinding is being carried out by the author.

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